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## NO DRAWINGS

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## (54) MAGNESIUM BASE DIE CAST ALLOY

(71) We, THE DOW CHEMICAL COMPANY, g Corporation organised and existing under the laws of the State of Delaware, United States of America, of Midland, County of Midland, State of Michigan, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

The invention relates to a magnesium base die cast, creep resistant, thermally conductive alloy containing aluminium, silicon and optionally manganese and zinc, the balance being essentially magnesium.

The A.S.T.M. designated AZ80C magnesium base alloy containing from 7.8 to 9.2 per cent aluminium, 0.15 minimum per cent manganese and from 0.2 to 0.8 per cent zinc, has been used in many structural applications due to its excellent strength properties. However, such alloys at elevated temperatures, e.g., 200—400° F./93—204° C., after extended periods of time are subject to extensive creep, finally leading to failure of the part. For example, a magnesium base die cast alloy containing 8.2 weight per cent aluminium 0.16 weight per cent manganese and 0.57 weight per cent zinc when subjected to 5000 pounds per square inch (psi)/352 kg/cm<sup>2</sup> creep stress for 100 hours at 350° F./177° C. has a per cent creep (% Creep) of about 1.7 per cent and shortly thereafter enters third stage creep and ruptures. Such failures are due in part to the alloy's relatively low thermal conductivity, thus requiring the structural part to operate at higher temperatures because the heat is not conducted away.

According to the present invention there is provided a magnesium base die cast alloy

having improved creep resistance and thermal conductivity consisting of from more than 3.0 per cent and up to 5.5 per cent aluminium, from 0.5 to 1.5 per cent silicon, from 0 to 1.0 per cent manganese and from 0 to 2.0 per cent zinc, the balance apart from impurities being magnesium. In a preferred aspect of the invention, the manganese is present in an amount of from 0.2 to 0.5 per cent. Also preferred are alloys containing zinc in an amount of from 0 to 1.0 per cent.

It has been surprisingly discovered that the die cast alloys within the present invention possess a unique combination of mechanical and thermal properties heretofore unknown in the metallurgy art. This may be due in part to a fine dispersion of magnesium silicide, Mg<sub>2</sub>Si, in the magnesium matrix obtained through die casting, i.e. rapidly solidifying the molten alloy.

In preparing the alloys of the present invention, conventional melting, alloying and die casting techniques, as practiced by those skilled in the art, may be employed, using alloying and base metal constituents containing the normal amounts and types of impurities.

The following examples are representative of the novel magnesium base die cast alloys of the present invention and are not intended to be construed as limiting the invention thereto.

## EXAMPLES 1—4

Various magnesium alloys were conventionally prepared, ladled into shot well or a die casting machine, and cast at 1200—1500° F./650—815° C. into a panel box 4.0 inches/10.2 cm. wide, 7.0 inches/17.7 cm. long and 1.0 inch/2.5 cm. high containing a centre boss 6.0 inches/12.7 cm. long by 3/16 inches/0.5 cm. high and wide. Samples were taken from

[Price 5s. 0d. (25p)]

- the face of the panel on either side of the centre boss and tested for ductility by per cent elongation (% E), strength properties by tensile strength (TS) and tensile yield strength (TYS) in thousand pounds per square inch (KSI)/10.3 kg./cm<sup>2</sup>, thermal conductivity through the electrical conductivity constant (K—mhos/cm<sup>2</sup>) and creep resistance by per cent creep (% Creep) after 100 hours at 350° F./177° C. under 5000 psi/352 kg./cm<sup>2</sup> stress. The table presents the results of these tests.

TABLE

Example No.	Composition*					TYS	TS	% Creep	K**
	% Al	% Si	% Mn	% Zn	% E				
Comparative (A)	8.2	—	0.16	0.57	2.5	21.5	30.0	1.7	7.3
Comparative (B)	9.6	0.69	0.14	0.49	1.0	24.0	32.0	1.5	6.4
Comparative (C)	8.0	—	0.17	0.58	0.9	20.8	26.0	3.1	7.4
Comparative (D)	6.1	—	0.35	0.49	4.0	19.1	28.2	4.6	8.1
Comparative (E)	2.0	—	—	—	8.4	13.1	25.7	6.0	13.3
1	4.2	0.93	0.24	—	4.4	21.6	31.6	0.32	9.0
2	4.1	0.52	0.39	—	7.5	18.8	33.1	0.54	9.4
3	4.0	0.99	—	—	5.5	20.5	32.8	0.35	9.2
4	3.8	1.22	0.27	—	3.0	20.8	28.6	0.30	8.4

\*The balance being essentially magnesium

\*\*K measured in 10<sup>4</sup> mhos/cm<sup>2</sup>

- In the Table the first comparative example (A) is essentially of the same composition as the commercial, A.S.T.M. designated AZ80C alloy which possesses high strength but relatively low thermal conductivity, ductility, and creep resistance. Comparison B, while having silicon within the present invention limits, has an aluminium content outside the range operable for the alloy of the present invention. Although having adequate strength, B possesses relatively poor creep resistance.

- The alloys of the present invention as exemplified by Examples 1—4 have greatly improved creep resistance as indicated by lower % creep, higher ductility as shown by an increased % E, and improved thermal conductivity as measured by increasing K values, at little or no sacrifice in strength (TYS).

Although the presence of manganese is preferred, it is not necessary to obtain the improved creep resistance, thermal conductivity

and ductility of the alloys of the present invention.

#### WHAT WE CLAIM IS:—

1. A magnesium base die cast alloy having improved creep resistance and thermal conductivity consisting of from more than 3.0 per cent and up to 5.5 per cent aluminium, from 0.5 to 1.5 per cent silicon, from 0 to 1.0 per cent manganese and from 0 to 2.0 per cent zinc, the balance apart from impurities being magnesium.

2. A magnesium base die cast alloy as claimed in claim 1, the manganese being present in an amount of from 0.2 to 0.5 per cent.

3. A magnesium base die cast alloy as claimed in either one of the preceding claims, the zinc being present in an amount of from 0 to 1.0 per cent.

4. A magnesium base die cast alloy as claimed in claim 1 substantially as hereinbefore described with reference to the Specific Examples.

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